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SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Technologies (5)

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DEPLOYABLE MECHANISMS FOR SMALL TO MEDIUM-SIZED SPACE DEBRIS REMOVAL

Abstract

This research aims to propose a new paradigm in orbital debris removal systems. While most groups addressing this issue focus on the high priority of removing the largest debris, we consider the threat posed by those smaller than 10cm as serious. A 2cm paint chip is known to be able to render useless most spacecraft as well as being way more difficult to follow and thus to avoid. We propose a mission to sweep the main LEO orbits with a 400 to 900 metre diameter cupola that would collect small debris. The cupola consists of a deployable mechanism supporting a membrane. The deployment mechanism would reach an expansion ratio of about 30, in order to create a very wide collecting surface. The membrane covering its surface would be rigid enough to capture most small debris and to at least slow down the medium-sized ones, accelerating their fall. An overview of the hybrid tensegrity and rigid-link mechanism proposed to support the collecting surface will be presented. The proposed mechanisms are based on previous work on deployable mechanisms developed for a variety of applications. However, conventional deployable rigid-link mechanisms typically produce expansions that are much smaller that the ratio required in the present application. Therefore, cable systems are included in order to further increase the expansion ratio while maintaining a low mass. While in operation, the cupola will obviously be subject to many ultra-high-velocity impacts and its orientation will likely undergo deviations from the targeted optimum. Therefore, another important feature of the proposed debris removal concept is the development of means of reorienting and stabilizing the cupola using internal electric deployment actuators instead of fuel thrusters. The concept of reorientation using internal actuators will be presented and simple examples will be provided. Finally the trajectory and overall mission planning are developed using data from MASTER09 and will be revised in the upcoming months with the fresh release of ORDEM3. This data serve as the basis for the design specifications. Space debris removal is a high priority for the future of space missions and space exploration. The approach proposed here is believed to be one of the pieces of the puzzle.